EPRI ELECTRIC POWER RESEARCH INSTITUTE

Energizing California's Communities with Renewables

Waste Heat-to-Power at a Textile Dyeing Facility in Hawthorne

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Agenda

1. Background
2. Goals and Deliverables
3. Industrial Host Site
4. ORC Technology
5. Project Schedule
6. Potential Ratepayer Benefits

Background

- U.S. DOE Estimates:
  - Industrial sector uses about one-third of total energy consumption in the U.S.
  - About 20%-50% of this energy is lost as waste heat.
- Waste heat to power applications typically target high-temperature processes where waste heat is between 500 – 1000 °F:
  - Geothermal
  - Thermal solar
  - Waste heat captured from large internal combustion engines and gas turbines
  - Biomass
- Organic Rankine cycle (ORC) equipment can utilize medium and low temperature waste heat streams to directly produce electricity.
- System efficiency ranges from 5% to 15% with no incremental fuel costs.
- ORC technology is not widely adopted in California.
- CEC project enables demonstration of technology at a customer site.

Goals and Deliverables

- Overall goals:
  - Demonstrate ORC technology at an industrial customer facility.
  - Provide information and tools necessary to expand the applicability of ORC technology to a wide range of industrial processes.
- Deliverables:
  - System performance against various exhaust gas conditions.
  - System availability, operating requirements and maintenance requirements.
  - Technology applicability and/or limitations in to industrial processes.
  - Key factors dictating project economics and life cycle costs.
  - Recommendations on how to accelerate adoption.

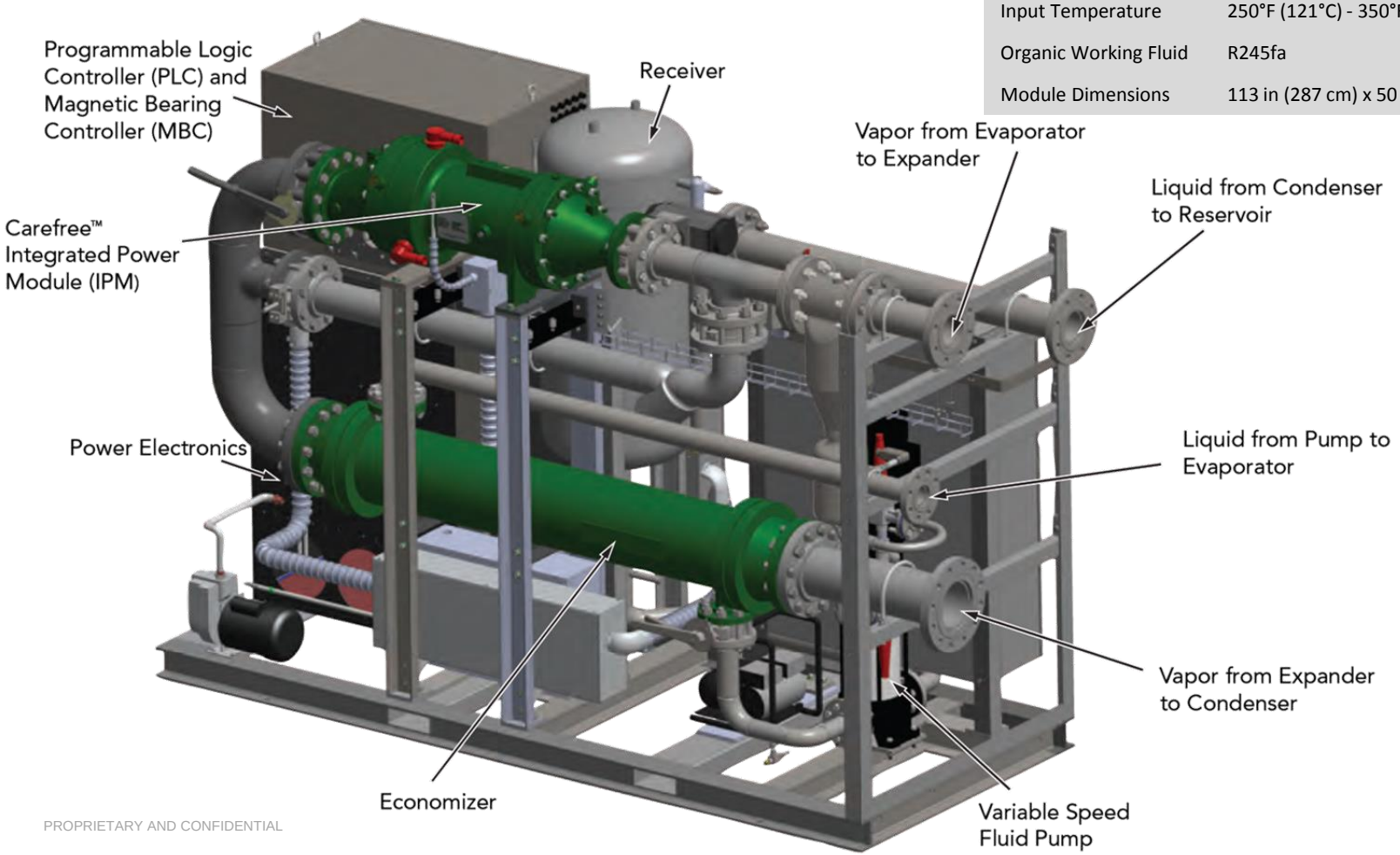
Industrial Host Site: American Apparel, Hawthorne, CA

Fabric Drying (Tenter) Ovens

Oven Duct System

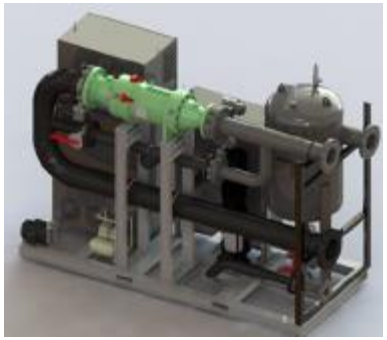
Thermapower™ MT

Parameters	Thermapower MT ORC Module
Power	125kW Gross
Voltage	3Ø, 380-480V 50/60 Hz
Input Temperature	250°F (121°C) - 350°F (177°C)
Organic Working Fluid	R245fa
Module Dimensions	113 in (287 cm) x 50 in (127 cm) x 80 in (203 cm)



Organic Rankine Cycle (ORC) Technology

- ORC System Selection: Calnetix Access Energy ORC.
  - Access Energy located in Cerritos, California
  - Thermapower MT unit electrical generating capacity is 125 kW (gross), good match for customer.
  - Net electricity output depends on balance of plant.
  - Modular configuration provides flexibility for evaporators, condensers.

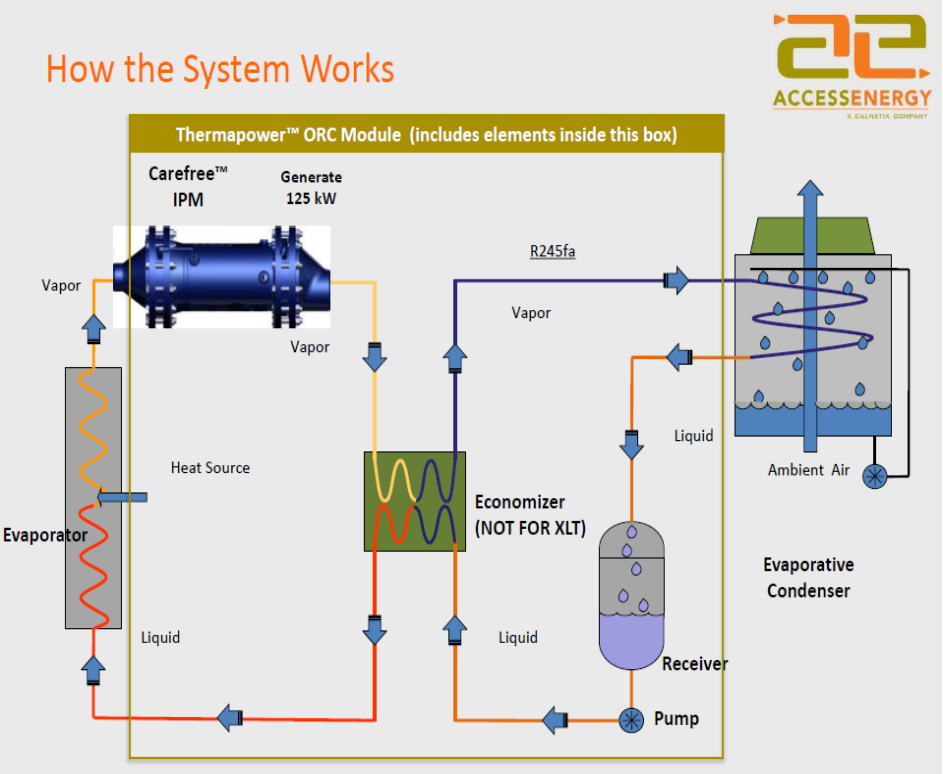


Calnetix ORC Machine

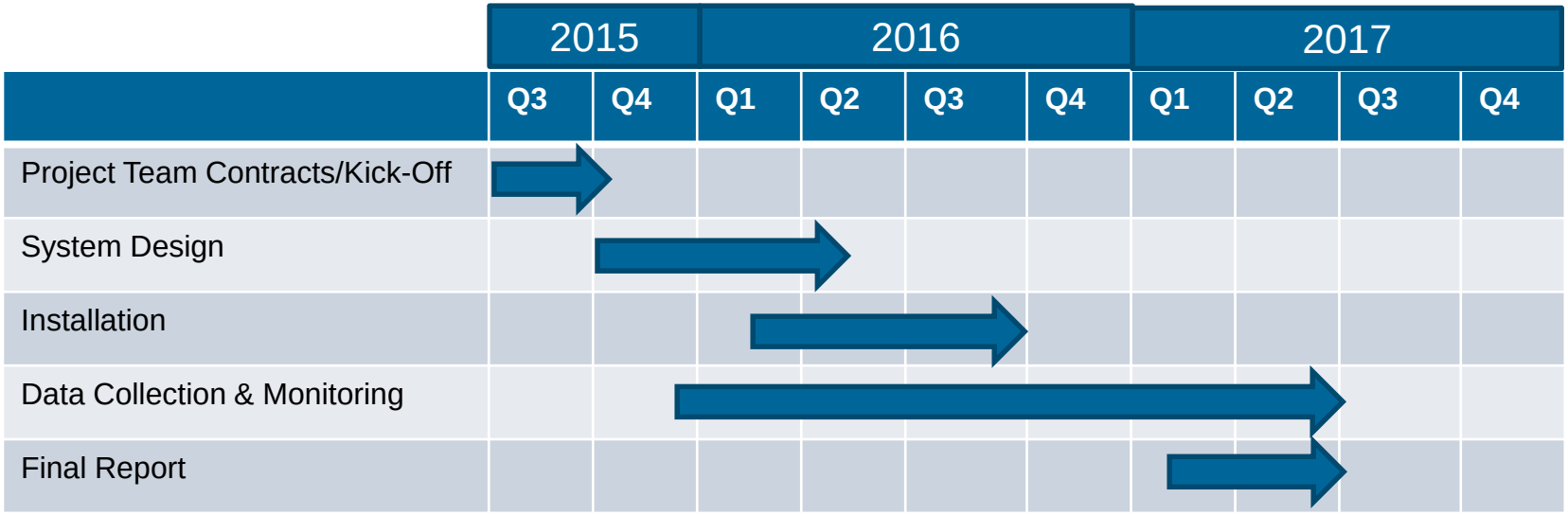
  - High speed turbine expander = higher efficiency than screw/scroll expanders.
  - Magnetic bearings with self-centering mechanism reduce losses due to contact between rotating parts and improve reliability.
  - Variable high speed generator allows for optimal speed operation with 98% generator efficiency and no need for gear box.
  - Program logic controller (PLC): provides real time optimization for variations in heat source temperature, cooling source temperature, and flow variations.
  - Power electronics: enables variable output frequency/voltage for real time grid conditions.

ORC Technology/Cycle

- The ORC cycle similar to other generation cycles, except that the organic working fluid, enables flexibility in evaporator temperature.
- A fluid with a lower boiling point enables us to extract power from lower temperature heat sources.



Project Schedule



Potential Ratepayer Benefits

- Increased electricity reliability
- Lower operating costs
- Increased safety (lower pressure steam)
- Reduced GHG emissions

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